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LARGE SPACE ANTENNA CONCEPTS FOR ESGP

Allan W. Love, Chairman
Rockwell International
Satellite and Space Electronics Division
Seal Beach, California

INTRODUCTION

As we began this conference, and particularly the session on Large Space Antennas, it was appropriate to note that 1988 marks the 100th anniversary of the birth of the reflector antenna. It was in 1888 that Heinrich Hertz constructed the first one, a parabolic cylinder made of sheet zinc bent to shape and supported by a wooden frame. It stood 2 meters high, had an aperture 1.2 meters wide, a focal distance of 0.12 meters and could be rolled about on casters. What we now call the feed was simply a spark gap-excited dipole placed along the focal line at its mid-point.

A similar reflector, dipole and spark gap detector served as a receiving antenna. With these two antennas and an induction coil to excite the transmitting spark gap, Hertz demonstrated the existence of the electromagnetic waves that had been predicted theoretically by James Clerk Maxwell some 22 years earlier. The frequency was about 450 MHz, corresponding to the $3/2$ -wavelength resonant dipole length.

In the 100 years since Hertz's pioneering work the field of electromagnetics has grown explosively. I cannot help but wonder what Hertz's astonishment would be if he were permitted a glimpse today of the technology that has grown out of his pioneering work. One of those technologies was the reason for attending this conference. It is the technology of remote sensing of planet Earth by means of electromagnetic waves, using both passive and active sensors located on an Earth Science Geostationary Platform (ESEP). This, of course, is the converse of what radio and radar astronomers have long been doing: remotely observing outer space, both near and far, with electromagnetic sensors on the Earth. For these purposes they have developed some exquisitely sensitive instruments, capable of reaching to the fringes of the known universe, and relying on large reflector antennas to collect the minute signals and direct them to appropriate receiving devices.

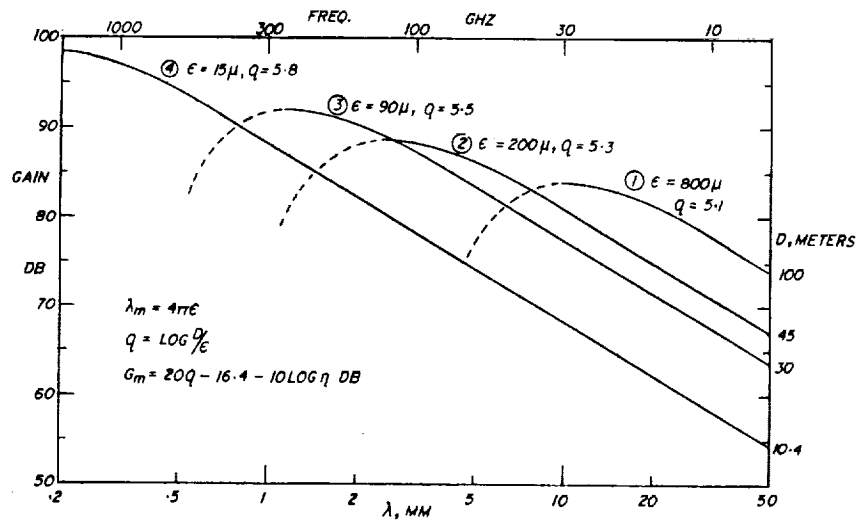
These antennas are electrically large, with diameters of 3000 to 10,000 wavelengths and with gains approaching 80 to 90 dB. They must have very smooth surfaces that deviate from the ideal paraboloid by no more than a few hundredths of a wavelength under the combined effects of varying gravitational and wind induced forces as well as changes in ambient temperature.

Some of the reflector antennas proposed for ESGP are also electrically large. For example, at 220 GHz a 4-meter reflector is nearly 3000 wavelengths in diameter, and is electrically quite comparable with a number of the millimeter wave radiotelescopes that are being built around the world. Its surface, too, must meet stringent requirements on rms smoothness, and ability to resist deformation. Here, however, the environmental forces at work are different. There are no varying forces due to wind and gravity, but inertial forces due to mechanical scanning must be reckoned with. With this form of beam scanning, minimizing momentum transfer to the space platform is a problem that demands an answer.

Finally, reflector surface distortion due to thermal gradients caused by the solar flux probably represents the most challenging problem to be solved if these Large Space Antennas are to achieve the gain and resolution required of them.

The session provided a stimulating discussion of these and other problems whose solutions are being investigated by the authors in this publication.

GAINS OF SOME LARGE, GROUND-BASED RADIO TELESCOPE REFLECTOR ANTENNAS



1. MPIFR, BONN FRG (EFFELSBURG, FGR)
2. TOKYO OBSERVATORY (NOBEYAMA, JAPAN)
3. IRAM, FRANCE/GERMANY (PICO VELETA, SPAIN)
4. CALIF. INST. TECHNOLOGY (MAUNA KEA, HAWAII)

THE FIRST REFLECTOR ANTENNA HERTZ'S PARABOLIC CYLINDER, 1888

